

DEMOUNTABLE DRIVE MECHANISM

Cross Reference to Related Applications

[0001] This application is a Continuation-in-Part of Application Serial No. 09/855,752, filed on July 29, 2003, which is a Continuation-in-Part of Application Serial No. 09/787,711, filed on March 21, 2003, and now abandoned.

Field of Invention

[0002] The present invention relates to a demountable drive mechanism for coupling to a drive shaft of an operating device.

Background Art

[0003] Manual cranking is the most common and simple technique of providing a mechanical advantage for the operation of devices that impart some kind of required displacement. The manual rotary operation of a crank handle is typically converted via gears or racks or the like to, usually, a linear motion of devices such as gates, doors, sides, roofs, decks, platforms and both flexible and rigid covering systems. It is still common today to use human manual effort to operate such devices. Several typical scenarios where manual rotation is required to operate devices are described below.

[0004] Landing gears for articulated trailers allows the raising, lowering and support of the forward end of the trailer in the engagement and disengagement from the prime mover (alternatively known as the tractor or truck) and allows the trailer to be freestanding whilst not in transit. In most instances the trailer itself is decoupled from a prime mover and then re-coupled to either the same prime mover or another depending on the logistics appropriate to the use.

[0005] A typical scenario is where a trailer is delivered to a loading dock for loading. The trailer will typically be loaded up to twenty tons in weight, and in some instances up to twenty five tons, on one trailer. The prime mover positions the trailer in the loading dock. The operator will de-latch the kingpin from the turntable

(alternatively known as the fifth wheel) and disconnect the service lines. The operator will then manually lower the legs of the landing gear. First the landing gear will be lowered to ground level in the higher speed selection of the typically two-speed geared landing gear arrangement. Once engaged with the ground the operator generally has no option other than to change to the lower speed selection where the operator will enjoy the significant increase in mechanical advantage afforded by the higher gear ratio. The operator will then with significant effort raise the forward end on the trailer to clear the trailer kingpin from the turntable of the prime mover. Once the trailer king pin is clear of the prime mover turntable the prime mover can be driven clear of the trailer to leave the trailer freestanding. The prime mover is then typically utilized elsewhere in a more productive role than being idle whilst the trailer is loaded.

[0006] The trailer will then be loaded which may take a portion of an hour or it may take several days. Once the trailer is loaded a prime mover will then return to the trailer for the removal from the loading dock. In many instances the prime mover will not be the same unit. In such cases the turntable height may not be identical or in other instances due to the poor stability of the ground on which the landing gear rests the trailer may have sunk. In either of these instances the height of the trailer will need to be adjusted to mate with the prime mover. The operator has the onerous task of manually winding the trailer either up or down to the necessary height. Once the trailer is at the correct height for engagement with the prime mover the operator can then locate the prime mover under the trailer, mating the kingpin with the turntable.

[0007] To prepare the trailer for transport the legs are manually raised in low speed until they are once again clear of the ground. Having cleared the ground the weight of the loaded trailer is transferred from the landing gear to the prime mover this then allows the landing gear to be changed by the operator to high speed for the legs to be raised to their full height. Raising to full height is necessary to allow ground clearance for traveling both on the road system and in some instances off the road system. Most known landing gear utilizes a two-speed operation and typically the increase in mechanical advantage enjoyed in low speed is in the order of ten to

one over the high speed. Even with the advantages afforded by the two-speed operation the time to couple a trailer with a prime mover will find 15 minutes as not atypical. This is particularly so when a trailer is loaded to its limits which generally requires the operator to rest due to the physical fatigue associated with the manual effort required.

[0008] There are several teachings of prior art documenting many variations of powered drives that can be added to existing landing gear jacking legs at either the time of installation of the leg or a subsequent time. US Patent number 5,451,076 to Burkhead, US Patent number 5,299,829 to Rivers, Jr, et al, US Patent number 5,050,845 Aline, et al and US Patent number 5,004,267 to Busby teach of a pneumatic motor to provide the necessary motive force to rotate the crank shaft (drive shaft) of the landing gear prior art. US Patent number 4,466,637 to Nelson teaches of a drive motor such as an electric motor whilst we learn from US Patent 4097840 to Chappelle of an electric drive motor. It is noted that all of this prior art has existed for some time yet there is no significant commercialization of this art. The pneumatic teachings have not been accepted due their complexity and expensive nature of their pneumatic componentry. The prior art teachings of electrical motors is cumbersome, weighty and dated in technology. All the prior art tends to be overly complex and does not readily mount up to all commercial landing gear currently available and used within the trucking industry. Most of the prior art requires a strong dependence on the provision of power from the prime mover, that is, the prime mover is required to be coupled to the trailer for the prior art to function.

[0009] Another typical scenario of manual operation on a device is where a trailer is used to deliver cereal grain to a holding silo. The trailer is built in the general configuration of a hopper or multiple hoppers so that the grain can be dumped via doors (sometimes known as gates) at the bottom of each hopper within the trailer. When a trailer arrives at a silo the truck driver has to stop the vehicle, disembark from the truck and walk to the hopper door(s). He will then take a separately mounted crank handle and locate it on the spigot (typically hexagonal) of a rotary shaft that is connected to a gear which activates a gear rack, the rack being part of the hopper gate. When the truck driver rotates the crank handle manually he will impart a force

to the mechanical arrangement described above which will open the hopper door allowing the grain to be emptied from the trailer.

[0010] When the hopper is empty the driver will then return to manually close the hopper door. The loads on the hopper door are considerable resulting in high manual efforts required to operate these doors. Aside from being heavy work, this is also time consuming as each door can only be operated one at a time and the driver is required to be present to provide the manual effort.

[0011] In a further typical scenario manual effort is required to expand a section of vehicles or trailers have expanding sections to create more internal space whilst stationary parked or whilst being loaded. While in motion these sections in trailers are retracted. A hospitality trailer may typically have a manual crank arrangement that uses shafts and gears in combination with racks at the four corners of an expanding side to manually wind the side in and out to effectively nearly double the width of a trailer. Such an arrangement can require significant forces, which are manually imparted on the crank to operate such a device. Like a hopper door it can be heavy, time consuming and inefficient use of time for an operator, particularly if there are many sides to be activated.

[0012] There have been many attempts to minimize the effort and improve the efficiency of manually wound devices by utilizing powered systems such as hydraulics, pneumatics and electrical power sources. However, known electrical motors, hydraulics and pneumatics used to replace manual winding is cumbersome, weighty and dated in technology. All the prior art tends to be either overly complex, heavy, bulky or does not readily mount up to all commercial applications available and uses. In the transport and related industries, most of the prior art requires a strong dependence on the provision of power from the truck, that is, the truck is required to be coupled to the trailer for the prior art to function.

[0013] It is these problems that have brought about the present invention.

Summary of the Invention

[0014] In one aspect the invention provides a demountable drive mechanism for coupling to a drive shaft of an operating device, the drive mechanism being

directly secured to the drive shaft to cause the drive shaft to rotate, the drive mechanism comprising a geared electric motor having an output for coupling to the drive shaft, the drive mechanism having a torque arm adapted to engage a reaction surface so that the electric motor can impart torque to the drive shaft, and control means to control operation of the electric motor.

[0015] In another aspect the invention provides a demountable drive mechanism for coupling to a drive shaft of a hopper door in a hopper trailer, the drive mechanism being directly secured to the drive shaft to cause the drive shaft to rotate, the drive mechanism comprising a geared electric motor having an output shaft for coupling to the drive shaft, the drive mechanism having a torque arm adapted to engage the trailer body so that the electric motor can impart torque to the drive shaft, and control means to control operation of the electric motor.

[0016] In a further aspect the invention provides a demountable drive mechanism for coupling to a drive shaft of an operating device for displacing a wall of an extendible trailer, the drive mechanism being directly secured to the drive shaft to cause the drive shaft to rotate, the drive mechanism comprising a geared electric motor having an output shaft for coupling to the drive shaft, the drive mechanism having a torque arm adapted to engage the trailer body so that the electric motor can impart torque to the drive shaft, and control means to control operation of the electric motor.

[0017] In a still further aspect the invention provides a demountable drive mechanism for coupling to a drive shaft of an operating device for displacing a rollover tarping system on a trailer, the drive mechanism being directly secured to the drive shaft to cause the drive shaft to rotate, the drive mechanism comprising a geared electric motor having an output shaft for coupling to the drive shaft, the drive mechanism having a torque arm adapted to engage a reaction surface so that the electric motor can impart torque to the drive shaft, and control means to control operation of the electric motor.

Description of the Drawings

[0018] Embodiments of the present invention will now be described by way of

example only with reference to the accompanying drawings in which:

- **[0019]** Figure 1 is a side elevational view of a truck and trailer,
- [0020]** Figure 2 is a side elevational view of the trailer when detached from the truck,
- [0021]** Figures 3a and 3b are elevational views of a common form of trailers landing gear used with the trailer of Figure 2,
- [0022]** Figure 3c is a perspective view of a gear change mechanism of the landing gear of Figures 3a and 3b,
- [0023]** Figure 4 is a side elevational view of landing gear in accordance with an embodiment of the invention,
- [0024]** Figure 5a is a side elevational view of part of the landing gear of Figure 4 in a first speed mode,
- [0025]** Figure 5b is a side elevational view of the landing gear in a second speed mode,
- [0026]** Figure 6 is an exploded perspective view of the landing gear,
- [0027]** Figure 7 is a diagram of the circuit associated with the landing gear,
- [0028]** Figure 8 is a perspective view of a landing gear with demountable drive system in accordance with the second embodiment,
- [0029]** Figure 9 is an exploded perspective view of the drive system gear of Figure 8,
- [0030]** Figure 10 is an end on elevation view of a gearbox of the landing gear shown in Figure 9,
- [0031]** Figure 11 is a cross sectional view taken along the lines 11-11 of Figure 10,
- [0032]** Figure 12 is a cross sectional view taken along the lines 12-12 of Figure 10,
- [0033]** Figure 13 is a cross sectional view taken along the lines 13-13 of Figure 10,
- [0034]** Figure 14 is a cross sectional view similar to Figure 13 illustrating a limit switch operation,

[0035] Figure 15 is a schematic illustration of the wiring associated with the circuit of the second embodiment,

[0036] Figure 16 is an exploded perspective view of a simplified demountable drive system in accordance with a third embodiment,

[0037] Figure 17 is a cross-sectional view of the drive system shown in Figure 16,

[0038] Figure 18 is a part front elevation view of a conventional hopper trailer,

[0039] Figure 19 is an isometric view of a conventional expandable trailer,

[0040] Figure 20 is an isometric view of a conventional trailer with a roll over tarping system,

[0041] Figure 21 is a part front elevation view of the hopper trailer of Figure 18 incorporating the demountable drive mechanism according to one embodiment of the invention,

[0042] Figure 22 is an isometric view of the expandable trailer of Figure 19 incorporating the demountable drive mechanism according to another embodiment of the invention,

[0043] Figure 23 is an isometric view of the conventional trailer of Figure 20 incorporating the demountable drive mechanism according to yet another embodiment of the invention,

[0044] Figure 24 is an isometric view of a demountable drive mechanism with a manual override adapter according to a further embodiment of the invention,

[0045] Figure 25 is a schematic diagram of electronic control elements used in an embodiment of the demountable drive mechanism,

[0046] Figure 26 is a schematic diagram of electronic control elements used in another embodiment of the demountable drive mechanism,

[0047] Figure 27 is a graph of brush wear against motor current,

[0048] Figure 28 is a schematic illustration of an electric motor brush configuration, and

[0049] Figure 29 is a graph of motor current against time.

Detailed Description of the Embodiments

[0050] The following examples of use of the demountable drive mechanism concern its application of coupling to operating devices used in the transport and related industry, including trailer landing gears, hopper doors, displaceable covers and expandable sides on trailers. However, it is understood that the drive mechanism can be coupled to drive shafts of any suitable operating devices including those found outside the transport industry.

[0051] The use of the present invention on the landing gear for trailers is illustrated in Figures 1 and 2. In Figure 1 the landing gear 100 is illustrated in the position it occupies when the truck T and trailer 1 are in motion. In Figure 2, the landing gear 100 is illustrated in the position it occupies to support the trailer 1 when the prime mover (truck T) has been decoupled from the trailer 1.

[0052] As shown in Figures 3a and 3b, a conventional well known form of landing gear includes a pair of telescoping legs 101 and 102. Each leg includes an upper portion 2, 3 and a lower portion 4, 5 which telescopes into the upper portion 2 or 4 respectively. Each upper portion 2 and 3 is secured one to a side of the trailer chassis 1 with multiple bolts 9. The upper portions 2 and 3 of the telescoping legs are braced to each other with cross-bracing members 6 and 7. Each upper portion 2 and 3 of the telescoping legs 101 and 102 respectively is braced to the chassis by diagonal bracing members 8.

[0053] The driver's side leg 101 of the landing gear houses a two-speed reduction gear head illustrated generally as 103 as illustrated in Figures 3c. In the conventional mode of operation of the landing gear, the legs 101 and 102 are operated by a manual crank handle 10 which is removably attachable to the drive shaft 13 via a bolt. The leg 101 which houses the two-speed gear head 103 could also be mounted on the non driver's side.

[0054] Figure 3c illustrates the operation of the two-speed reduction gear 103. It is preferred that the gear head 103 is housed within the upper telescoping leg 2. In an alternative form, the gear head 103 is housed external to the upper leg section 2 and is arranged such that the gear reduction in one mode is not directly coupled. For clarity the gear head housing is not shown in Figure 3c. The purpose of the

mechanics of the gear train is to afford the significant mechanical advantage required when a human operator is manually raising or lowering a loaded trailer. The two-speed feature of the drive head of the landing gear is to allow a rapid motion of the telescoping legs 4 and 5 in either the up or down mode whilst they are not loaded with the trailer and/or its load.

[0055] The motive power for raising or lowering the telescoping legs 4 and 5 is usually from a human source or from a powered source. In the arrangement as shown in Figure 3a, the landing gear is powered by a human operator. The rotary motion (winding) of the crank handle 10 is imparted to the drive shaft 13 through the coupling bolt 12. When the drive shaft 13 is in the inboard position not shown in Figure 3c, the gear head is in the high speed mode where the least mechanical advantage is provided. The power is transmitted from drive shaft 13 to the spur gear 14 which is solidly attached to the drive shaft 13. In the inboard position the spur gear 14 is nested internally within the spur gear 18 and provides a direct drive to spur gear 18 which is solidly mounted to the shaft 19. The bevel gear 20 is also solidly mounted to the shaft 19. Drive is therefore from spur gear 18 through shaft 19 to bevel gear 20. Bevel gear 20 is permanently engaged with the mating bevel gear 21 which is affixed to the screw shaft 22. Screw shaft 22 provides the vertical motion to the telescoping legs 4 and 5 (not shown) via a mating nut (not shown) which is attached to the telescoping legs 4 and 5.

[0056] When transmission of power in low speed with the higher mechanical advantage is required the drive shaft 13 is in the outboard position shown in Figure 3c and clears the spur gear 18 and engages with the spur gear 15. Spur gear 15 is fixed to the lay shaft 16 which has gear 17 fixed to it. The drive is transmitted from drive shaft 13 to spur gear 14 to spur gear 15 through lay shaft 16 to spur gear 17 to spur gear 18. The transmission of power from spur gear 18 to the screw shaft 22 is identical as in high speed as described above.

[0057] This invention relates to the use of an electrical motor and associated control mechanism to provide drive to the output shaft to operate the landing gear. The control mechanism also provides means to effect the speed change mechanism by displacing the output shaft axially. The assembly has been specifically designed

to be retrofitted to the most common forms of landing gear. Thus, the assembly is adapted to drive the output shaft both in terms of rotation and axial displacement for speed change. The landing gear assembly and speed change mechanism described above is the commonly used system in the trucking industry.

[0058] According to one configuration of the apparatus according to the present invention shown in Figures 4 to 7, the manual crank handle 10 and is not used and motive power is provided by an electronically controlled geared electric motor. Preferably electrical energy is the power source and it is derived and converted from the prime mover's own internal combustion engine which is ultimately provided by the fuel that energizes that said engine. In alternative preferred embodiments, electrical energy is externally provided from other than the prime mover. A preferred power source for primarily stationary applications is the local civilian electricity grid. This power source is converted to the mechanical energy required to raise and lower the trailer complete with load as necessary. For the purpose of describing the invention electrical power is provided by the prime mover's own reticulated low voltage electrical system.

[0059] Energy is stored within the trailer in preferably two batteries 36 and 37. Two batteries are used to provide the necessary twenty-four volt operating electric potential that is used to power the electric motor 23. The batteries 36 and 37 are deep cycle heavy duty batteries that are capable of withstanding the duties appropriate to this rigorous invention. From Figure 7 it can be seen that the batteries 36 and 37 are electrically in series and are coupled together with conductor 71 being connected to the negative and positive terminals of batteries 36 and 37 respectively. The positive terminal of battery 36 is connected to the electronic controller 24 with conductor 72 via the single pin connector 81. The conductors 70, 71 and 72 are fixed to the terminals of the batteries 36 and 37 with bolts 38. The negative polarity of the battery 37 is coupled to ground, being the trailer chassis, via conductor 70. These batteries 36 and 37 are mounted within a battery case 40 which is secured to the landing gear. The battery case is enclosed with a sliding lid 43 which is capable of being secured through the inclusion of a lug 44 to prevent theft or tampering. The batteries 36 and 37 are snugly located by the use of a pliant membrane 39 that

insulates the batteries 36 and 37 from the battery case 40. This membrane 39 could typically be an expanded urethane sheet material. The battery case is secured to the leg of the landing gear with multiple self tapping screws 42 which are accessed when the batteries 36 and 37 are not in place via the clearance apertures 41. Alternative methods, locations and fixing for the batteries 36 and 37 may be appropriate for certain applications and as such are included in this invention. To minimize the distances of the high current electrical conductor 72 the batteries 36 and 37 are mounted adjacent the demountable geared motor assembly 104. The arrangement of batteries 36 and 37 , battery case 40, sliding lid 43, lug 44, pliant membranes 39 and self tapping screws 42 form the battery assembly 105 as depicted in Figures 5a and 5b.

[0060] The electronic controller 24 is mounted adjacent the electric motor 23 with multiple bolts 34. The electronic controller 24 chassis is earthed to the trailer chassis through conductor 73. The electric motor 23 is connected to the electronic controller 24 through conductors 79 and 80 via the two pin connector 82. The raise/lower switch 48 is directly connected to the electronic controller 24 through conductors 76 and 77. The common terminal of the raise/lower switch 48 is connected to earth via the conductor 78. The positive polarity of the trailer derived power supply (not illustrated) to the electronic controller 24 is feed through conductor 75 via the two pin connector 83 with the negative polarity being connected to ground through conductor 74.

[0061] In the embodiment as illustrated in Figure 7 the brake air pressure interlock switch 64 is connected to the electronic controller 24 through conductor 84 via the two pin connector 83. The brake air pressure interlock switch 64 common terminal is connected to ground through conductor 85.

[0062] As illustrated in Figure 7 two bi-directional electric solenoids 54 and 55 are connected to the electronic controller 24 through conductors 86 and 87 with the third necessary conductor from the electric bi-directional solenoids 54 and 55 connected to earth through conductor 88. The turntable clear interlock switch 65 is connected to the electronic controller 24 through conductor 91 with the common earthed through conductor 92. The legs up interlock switch 66 is connected to the

electronic controller 24 through conductor 89 with the common earthed through conductor 90. The two bi-directional solenoids 54 and 55, the turntable clear interlock switch 65 and the legs up interlock switch 66 are all connected to the electronic controller 24 via the 4 pin connector 93.

[0063] As one of the objectives of this invention is to be universally mounted, either a twelve volt or a twenty four volt trailer operating voltage can be received by the electronic controller 24. The electronic controller 24 will typically accept a voltage input range from 10 volts to 30 volts DC which is electronically converted to the necessary battery charging voltage to ensure the batteries are maintained at their peak operating condition. Charging is achieved at the operators discretion by providing the trailers reticulated voltage to the input connector 83 of the invention through conductors 75, 74 and 73. The electronic controller 24 includes circuitry to prevent failure of any of the electronic components should the batteries 36 and 37 or supply voltage (not illustrated) be inadvertently connected in the reverse polarity.

[0064] The electronic controller 24 receives indication from the raise/lower switch 48 as to the desired operation. This is achieved by effectively connecting conductors 76 or 77 to earth via the raise/lower switch 48 and conductor 78 for raise and lower modes respectively. The electronic controller 24 uses the indication as above-mentioned from raise/lower switch 48 to undertake the necessary high current voltage switching to operate the invention from the off to either the raise or lower modes. In effect the voltage as fed through the conductors 79 and 80 via connector 82 to the electric motor 23 is the battery voltage (in series) for the raise mode with the polarity being reversed across the conductors 79 and 80 and the electric motor 23 for the lower mode. Connector 82 is included to ensure that the electric motor 23 can be readily disconnected in the event of failure of the electric motor 23.

[0065] In this embodiment the electronic controller 24 includes an electronic circuit to ensure the electric motor 23 current is limited to a set value. If the load is such that the electric motor 23 attempts to use excessive current the electronic controller will de-energize the voltage being feed to conductors 79 and 80. The supply will not be re-energized until both a short time delay has passed and the raise/lower switch 48 has been cycled through the off position. Such over current

conditions will arise where the end of the stroke of the landing gear legs 4 and 5 has been reached and the electric motor 23 is left operating. Preferably when the landing gear legs are being lowered in high speed the invention allows the operator to undertake other routine duties as the overload protection component of the invention will stop the motor once the telescoping legs 4 and 5 have engaged the ground. The electronic controller 24 is configured so that the change from high speed to low speed will take place automatically as described elsewhere in these teachings.

[0066] From Figure 7 the raise and lower modes can be understood. The raise/lower switch 48 when in the raise mode effectively connects the conductor 77 to ground through raise/lower switch 48 and conductor 78. Whereas in the lower mode the conductor 76 is conducted to ground through raise/lower switch 48 and conductor 78. The raise/lower switch 48 as described herein has three positions. In the raise position the raise mode is energized, in the lower position the lower mode is energized and in the central off position the electric motor 23 is not activated. The raise/lower switch is a spring return centralizing type switch.

[0067] Figure 7 illustrates a trailer brake air pressure interlock switch 64. This switch is closed when the brake air pressure drops to a point where the trailer brakes (not illustrated) are positively engaged. The inclusion of this element of the circuit design is optional and at the discretion of the operator as some applications would be hindered by the inclusion of such an interlock.

[0068] In an alternative embodiment (not illustrated) the conductor 84 is connected to ground. If the brake air pressure interlock switch 64 is not installed the conductor 84 is required to be connected to ground, as such the electronic controller 24 will interpret the imaginary switch as being on.

[0069] In this embodiment sensors and actuators are included along with electronic control circuitry to allow the gear change in the trailer landing gear to be undertaken automatically. The turntable clear interlock switch 65 and the legs up interlock switch 66 are used to sense the completed lower and raise automatic cycles respectively of this embodiment of this invention. As described elsewhere in these teachings the bi-directional electric solenoids 54 and 55 are used to activate the change in gears within the trailer landing gear gear head 103

[0070] The electric circuit as herein described is one of several possible solutions to provide an operating system in a twelve or twenty four volt environment. Other options and variations, such as relays, may be equally suitable and inclusive in this invention.

[0071] The demountable geared electric motor assembly 104 comprises a drive motor that is preferably a direct current electric motor. The electric motor 23 is close coupled to a worm reduction gearbox 31. However it is understood that other reduction mechanisms could be deployed. Planetary gear trains, spur gear reduction and chain drives and combinations thereof are all considered suitable alternatives to the worm reduction gearbox described herein. The output male shaft 27 of the motor is positively coupled via a key 28 to the female input shaft of the gearbox 31. The electric motor 23 is secured to the mating gearbox flange 29 with multiple bolts 30. The gearbox 31 includes a hollow output shaft which is sized to be a slide fit on the landing gear drive shaft 13. This size may vary from one commercial landing gear to the next. The demountable geared assembly is mounted on and supported by the landing gear drive shaft 13 and includes a collar 32 which is an interference fit in the gearbox 31 hollow output shaft. The existing landing gear drive shaft 13 has a new hole 35 added to accept the pin 33 which passes through both the drive shaft 13 and the collar 32. This pin 33 is a press fit within the collar 32 and the hole 35. A torque arm 45 is supported from the upper leg 2 via bolts 46. This torque arm 45 is a slide fit in the pliable bushing 26 which in turn is fitted within a fork flange 25 protruding from the base of the electric motor 23 housing. The torque arm 45 is preferably made of spring steel. The entire demountable geared electric motor assembly 104 includes and is enclosed within a cover 47. The cover is secured to the gearbox 31 housing with multiple bolts 53. Spacers 52 are used as appropriate between the cover 47 and the gearbox housing. The electronic controller 24 is housed adjacent the electric motor 23 and is supported from the cover 47 with bolts 63. Electrical conductors as elsewhere described extend from the electronic controller 24 to the battery assembly 105, the electric motor 23, the trailer power supply (not illustrated) and other field devices all as illustrated in the circuit diagram of Figure 7.

[0072] In this embodiment the demountable geared motor assembly 104

includes two bi-directional electric solenoids 54 and 55. These are located diametrically opposed about the drive shaft 13 and the bodies of the electric solenoids 54 and 55 are secured to the cover 47 with multiple screws 56. The electric solenoid shafts 57 and 58 are connected to the landing gear upper leg 2. The landing gear upper leg 2 has a solenoid coupling bracket 61 which is secured to the landing gear upper leg 2 with screws 62. The electric solenoid shafts 57 and 58 are connected to the solenoid coupling bracket 61 via a pins 59 and 60. The electrical conductors as illustrated in Figure 7 connect the electric solenoids 54 and 55 to the electronic controller 24.

[0073] The preferred electric motor 23 has a high energy density ratio and is ideal in this application. It is compact and relatively light in weight which is a criterion in most freight applications. Drive from the electric motor 23 is transmitted to the gearbox 31 through the key 28 which in turn is transmitted to the landing gear drive shaft 13 via the collar 32 and pin 33. In addition to transmitting the drive torque the pin 33 provides the lateral fixing of the demountable geared electric motor assembly 104 to the landing gear. The torque applied to the landing gear drive shaft 13 by the electric motor 23 is resisted by the torque arm 45. The torque arm is specifically so placed to react to the torque applied in operation of the demountable geared electric motor assembly 104 to the landing gear drive shaft 13. The material used to manufacture the torque arm 45 provides a degree of flexibility. This flexibility allows any shock loading to the drive assembly to be minimized. When the demountable geared electric motor assembly 104 is laterally moved as illustrated in Figures 5a and 5b the torque affords a minimal rotational allowance to allow the meshing of the gears as the high speed or low speed is engaged. To allow for the lateral movement when the gear change is undertaken the torque arm 45 is a slide fit in the pliable bushing 26.

[0074] The cover 47 provides the necessary minimal guarding required to ensure operator safety as well as providing a base for the mounting of the bi-directional electric solenoids 54 and 55 and the electronic controller 24. The cover 47 accommodates the mounting of the raise/lower switch 48.

[0075] In the embodiment of Figures 5a and 5b the bi-directional electric

solenoids 54 and 55 are used to move the entire demountable geared electric motor assembly 104 inclusive of the drive shaft 13 laterally, that is, inboard and outboard. This lateral movement of the whole drive system reflects the change from high speed to low speed or vice versa within the geared head of the existing landing gear. The force applied by the solenoids in conjunction with the rotational flexibility provided by the torque arm are sufficient to ensure the speed change is positive and complete. Figure 7 illustrates bi-directional electric solenoids 54 and 55 of this embodiment.

[0076] According to another embodiment of the invention (not illustrated) the gear change from high speed to low speed and back again within the landing gear is carried out independent of the drive system. The geared electric drive motor assembly position is fixed and the landing gear drive shaft 13 is acted on by a mechanism that allows the change from high speed to low speed independent of the geared electric motor drive assembly. In this embodiment the coupling between the landing gear drive shaft 13 and the demountable geared electric motor drive assembly 104 is a keyed slide fit of the landing gear drive shaft 13 within the hollow shaft of the reduction gearbox 31.

[0077] A typical scenario for an automatic down cycle is initiated, when the system is not already operating, by the operator flicking the raise/lower switch 48 to the lower position for approximately one second. The electronic controller 24 then activates the bi-directional solenoids 54 and 55 to ensure the gear head 103 is in the high speed mode. The lower legs 4 and 5 are then lowered by the electric motor 23 as elsewhere described. When the landing gear lower legs 4 and 5 become engaged with the ground the electric motor 23 current eventually reaches its defined upper current limit and the electric motor 23 is stopped by the electronic controller 24. It should be noted at this point that in some circumstances the trailer and load may be so insignificant that the electric motor 23 current upper limit is not reached and the landing gear lower legs 4 and 5 can continue to be lowered in the high speed mode. The bi-directional solenoids 54 and 55 are activated to change the gearing to the higher ratio where the improved mechanical advantage is enjoyed. Upon this gear change being effected the electric motor 23 is again energized to continue lowering the landing gear. The automatic lower cycle is concluded on reaching one of three

conditions:

[0078] The first condition being the electric motor 23 current has again reached the defined upper limit.

[0079] The second condition being that the turntable clear interlock switch has been activated.

[0080] The third condition is that the raise/lower switch 48 has been flicked to the raise position for approximately one second.

[0081] The automatic raise mode of this embodiment is activated, when the system is not already operating, and the raise/lower switch 48 is flicked to the raise position for approximately one second. The electronic controller 24 then activates the bi-directional solenoids 54 and 55 to ensure the gear head 103 is in the low speed mode. The lower legs 4 and 5 are then raised by the electric motor 23. When the turntable clear interlock switch is deactivated the electronic controller 24 stops the electric motor 23 after a short predefined period of time. The bi-directional solenoids 54 and 55 are activated to change the gearing to the lower ratio where the increased operation speed is enjoyed. Upon this gear change being affected the electric motor 23 is again energized to continue raising the landing gear. The automatic raise cycle is concluded on reaching one of three conditions:

[0082] The first condition being the electric motor 23 current has again reached the defined upper limit.

[0083] The second condition being that the legs up interlock switch 66 has been activated.

[0084] The third condition is that the raise/lower switch 48 has been flicked to the lower position for approximately one second.

[0085] In this embodiment of automatic gear changing there will be times when the landing gear lower leg 4 and 5 extension needs to be adjusted. This is achieved by holding the raise/lower switch 48 in either the raise or lower position for a period greater than two seconds. The electronic controller 24 will recognize this holding of the raise/lower switch 48 and not continue in an automatic mode but only raise or lower the legs for the period that the raise/lower switch 48 is held in either the raise or lower position respectively. Manual gear change can still be undertaken and is

consistent with the non-automatic gear change embodiment in that the gear change is effected by the operator manually acting on the demountable geared motor assembly 104.

[0086] According to yet another embodiment (not illustrated), the gear change is manually operated.

[0087] In this embodiment the gear change is manually undertaken by the operator acting on the demountable geared motor assembly 104 which includes operator handles 50 and 51. The operator either pushes or pulls the whole demountable geared motor assembly 104 inboard or outboard thereby laterally shifting the drive shaft 13 and effecting the gear change in the gear head 103 of the landing gear.

[0088] A typical scenario of the operation of the system in a non-automatic mode is described as follows. The operator having positioned the trailer in the area ready for decoupling from the prime mover will, after having secured the brakes on the trailer, ensure the gear head is in the high speed disposition. In this position the raise/lower switch 48 will be activated to the lower position and the inner telescoping legs 4 and 5 of the landing gear will quickly lower to the ground. The operator has the option to wait at the legs until this occurs or he may elect to undertake a few other duties that are part of his decoupling routine. When the legs make contact with the ground if the operator does not return the raise/lower switch 48 to the off position the electronic motor controller 24 will prevent the drive from over loading and switch itself off. The raise/lower switch will then need to be returned to the central off position. After engaging the ground the operator will then make the change to low speed by grasping the handles 50 and 51 and undertaking the minimal lateral movement to engage low speed. In low speed a significant mechanical advantage is provided by the landing gear gear head 103 and the operator can now re-energize the system in the lower mode by activating the lower mode of the raise/lower switch 48. Once the trailer has been raised so that the trailer kingpin is clear of the prime mover turntable the raise/lower switch is returned to the off position. When the operator has undertaken all other service disconnection's between the prime mover and the trailer the prime mover can be driven clear and the trailer left as a freestanding unit.

[0089] When the freestanding trailer is required to re-coupled to a prime mover the operator will assess if the trailer is at the appropriate height. If not then the operator will ensure the low speed is engaged within the gear head of the landing gear. The height of the trailer can be adjusted by operating the raise/lower switch 48 as appropriate. Once the trailer is at the correct height the prime mover can be located under the trailer. The trailer landing gear legs 4 and 5 can now be raised to be clear of the ground by operating the raise/lower switch 48. Once clear of the ground the operator can engage the high speed mode within the landing gear and continue to raise the legs until they are in the fully retracted position. Once the legs are fully retracted in the raised position the raise/lower switch 48 is returned to the central off position. If the operator does not turn off the raise mode before the landing gear has reached its uppermost position the electronic controller 24 will take over and de-energize the electric motor 23. After completing all other couplings between the trailer and the prime mover the trailer is then ready to be removed from its freestanding position.

[0090] As in all mechanical and electrical mechanisms failure can occur and the system caters for this in that the demountable geared electric motor assembly 104 is readily removed. The procedure for removal of the drive assembly is as follows: The electrical connectors 81 and 83 are disconnected, in an alternative embodiment connector 93 it is also disconnected. The pin 33 is removed and the whole drive assembly can be demounted by sliding the assembly outboard and off both the landing gear drive shaft 13 and the torque arm 45. Once this is carried out the original manual crank handle 10 is remounted to the landing gear drive shaft 13 with a bolt nut (not illustrated). The operator can then operate the landing gear in the traditional manner. The manual crank handle 10 is separately stored on the trailer in the advent that a failure was forthcoming.

[0091] In the embodiment shown in Figures 8 to 15, a more compact system 200 is used to drive the landing gear. The system is similar to the embodiments described above by utilizing an electric motor 201 that is supported in a housing 202 that in turn supports a gearbox 203 positioned between the output shaft 204 of the electric motor and a drive shaft 205 which is in turn coupled to the drive shaft 13 of

the landing gear. As shown in Figure 8 the motor 201 is positioned with its axis parallel to the drive shaft 205 and the gearbox 203 is located at the outboard end 207 of the assembly. The lower rear face of the housing 202 has a projecting spigot (not shown) that is a sliding fit within a torque arm in the form of a steel rod 209 that is secured to the leg of the landing gear via an angled bracket 206. The torque arm 209 facilitates transfer of torque from the electric motor 201 to rotate the shaft 13 of the landing gear. This embodiment also includes an automatic gear change facility, except in this case the gear change facility is pneumatically driven by the air pressure that emanates from the trailer's air braking system.

[0092] As shown in Figures 9 and 11, the housing 202 is split into two parts, namely a front cover 211 that can be bolted to a rear part 212 of the casing that houses the gearbox 203. The upper part of the housing defines a sub-compartment 215 which is sealed from the remainder of the housing and which contains a circuit board 216. A main operator panel 217 is attached to the exterior surface of the sub-compartment 215. The output shaft 205 of the gearbox has an enlarged hollow spigot 218 which extends co-axially into a cylindrical drum 220 that is sealed by an end plate 221 to define an air chamber.

[0093] The input shaft 13 of the landing gear locates coaxially in a fixed collar 225 that is mounted to the leg of the landing gear. The collar 225 steps down to an elongate sleeve. The sleeve 226 has an axially hollow projection 227 that terminates in an annular face plate 230. As shown in Figures 11 and 12, the input shaft 13 locates within the spigot 218 of the output shaft 205 of the gearbox 203. As shown in Figure 12, the spigot 218 and input shaft 13 are secured together by a transverse pin 231 that ensures transfer of axial rotation as well as axial displacement to the input shaft of the landing gear.

[0094] The arrangement is such that the housing 202 together with the electric motor 201, gearbox 203 and drum 220 can move axially relative to the collar 225, sleeve 226, limit switch actuating arm and face plate 230 to displace the input shaft 13 to effect a speed change. The face plate 230 contacts the interior of the drum 220 and exterior of the spigot 218 via 'O' ring seals 232, 233 to divide the air chamber into two sub-chambers 235, 236 on either side of the face plate 230. An 'O' ring seal

234 also acts between the end plate 221 and the sleeve 226 allows relative movement whilst maintaining air pressure within the sub-chamber 236.

[0095] The compartment of the housing 202 that houses the gearbox 203 can be pressurized from the trailer's air brakes to act as an air pressure reservoir that can contain enough pressurized air to facilitate operation of the speed change mechanism. The air pressure within the gearbox housing 202 is transmitted to the sub-chambers 235, 236 via solenoid controlled valves 240, 241 shown in Figures 12 and 13. The left hand valve 240 is shown in Figure 12 and comprises a valve member 242 urged outwardly by a spring 243. The solenoid 154 drives the valve member 242 inwardly against the spring 243 to allow air to flow into the sub-chamber 235 on the left hand side of the face plate 230. In the neutral position, the spring 243 pushes the valve member 242 to the left as shown in Figure 12 which allows the sub-chamber 235 to vent to atmosphere through a small bleed aperture 248 shown in Figure 12. The sub-chamber 236 on the other side of the face plate can also bleed to atmosphere via bleed aperture 249 and the other solenoid controlled valve 241 shown in Figure 13.

[0096] By actuation of either valve through the solenoids 154, 155 the sub-chambers 235, 236 are pressurized to cause the housing 202 to be displaced relative to the fixed sleeve 226 and face plate 230. This displacement of 22 to 25 mm is all that is required to effect the speed change. The sub-chambers can be vented to atmosphere in the neutral positions of the valves to ensure that there is a simple opportunity for manual override should there be a loss of air pressure. The gearbox enclosure is an elegant means of providing a reserve of air pressure so that the speed change mechanism can operate a number of times without the need for further pressurized air from the prime mover.

[0097] In this embodiment the pneumatic actuation of the speed change is at low pressure, approximately 15 psi. The compressed air is supplied to the housing 202 via flexible piping (not shown) from the existing compressed air system that is used to actuate the trailer's braking system. The air pressure is regulated to the desired low pressure by an inline pressure regulator. A check valve (not shown) is incorporated in the supply line to ensure against inadvertent loss of air pressure from

the housing. Whilst the housing of the gearbox 203 is used as a low pressure air reservoir, it is understood that a safety over pressure relief valve (not shown) is fitted to the housing to ensure against over inadvertent increase of air pressure within the housing that might blow the seals.

[0098] The narrow bleed apertures 248, 249 that cause the sub-chambers 235, 236 to vent to atmosphere in the neutral position of the valves are specifically designed to slow down the release of air to act as a device that cushions the travel of the face plate 230 in either direction.

[0099] It is understood that instead of using the gearbox housing 202 as an air pressure reservoir, a separate tank or cylinder could be utilized in line with the air supply. The pneumatic system provides a smooth and positive speed change facility which can be finely tuned by controlling the air pressures to ensure efficient operation. The assembly has been specifically designed to be reduced to the competitive cost for a minimum weight and complexity.

[00100] As shown in Figure 14, a limit switch actuating arm 250 of offset section is solidly mounted on the collar 225 to extend towards the exterior of the drum 220. A pair of limit switches 167 and 168 are mounted on the circuit board 216 to be activated by contact with the end 251 of the arm 250 as the housing moves relative to the collar 225. As the axial movement of the system 200 reflecting a gear change is undertaken the actuating arm acts on the miniature limit switches 167 and 168. Miniature limit switches 167 and 168 are electrically connected to the circuit board 216 as described later in the specification.

[00101] As shown in Figure 15, energy is stored within the trailer in preferably at least one battery 136. A battery 136 is used to provide the necessary twelve volt operating electric potential that is used to power the electric motor 201. From Figure 15 it can be seen that the positive and negative terminals of battery 136 are connected to the circuit board 216 with dual conductor 170 and a multiple core conductor 171 via a dual pin connector 181 and connector 186. The connector 186 is directly mounted on the circuit board 216. The dual conductor 170 is fixed to the terminals of the battery 136 with bolts (not shown). The conductor from the positive polarity of the battery 136 includes an in-line thermally acting fuse 137. The battery

136 is mounted within a battery cradle (not shown) which is secured to the landing gear 2.

[00102] The circuit board 216 is mounted within the housing sub-compartment 215 of the system 200 and is located via a snug fit within two parallel slots on either internal side of the housing sub-compartment 215. The electric motor 201 is connected to the circuit board 216 through dual conductor 172 which is directly affixed to the circuit board 216. The main operator panel 217 is electrically coupled to the circuit board 216 with the multiple core conductor 173 via the circuit board 216 mounted connector 187. The positive and negative polarity of the trailer derived power supply (not illustrated) is coupled to the circuit board 216 through the dual conductor 178 via the multiple pin connector 189, the multiple core conductor 171 and the circuit board 216 mounted connector 186.

[00103] In the embodiment as illustrated in Figure 15 the brake air pressure interlock switch 164 is connected to the circuit board 216 through conductors 182, 179 and 171 via the connectors 191, 189 and 186. Two electric solenoids 154 and 155 are connected to the circuit board 216 through conductors 174 and 175 which are directly affixed to the circuit board 216. The turntable clear interlock switch 165 is connected to the circuit board 216 through conductors 183, 180 and 171 connectors 192, 189 and 186. The legs up interlock switch 166 is connected to the circuit board 216 through conductors 184, 181 and 171 with connectors 193, 189 and 186. The alternate operator panel 169 acts identically to the main operator panel 217 and is electrically connected in parallel with the main operator panel 217. The alternate operator panel 169 is connected to the circuit board 216 with the multiple conductors 177 and 176 and multiple connectors 190 and 188. Two industry standard miniature limit switches 167 and 168 are mounted directly to the circuit board 216. Two light emitting diodes 194 and 195 are mounted directly to the circuit board 216. Both diodes emit light through apertures in the main operating panel 217. Multiple pin connectors 186 and 188 are mounted electrically directly to the circuit board 216 and physically to apertures in the rear of the housing sub-compartment 215. Connectors 186 and 188 are included to ensure that the system 200 can be readily disconnected in the event of failure of any of the components.

[00104] Multiple conductors 171 and 176 and their associated connectors and downstream conductors effectively form electrical looms and are used to connect to all electrical devices remote from the system 200 housing and the enclosed circuit board 216. The connectors 186 and 188 are environmentally sealed at the interface with the housing sub-compartment 215.

[00105] The control circuitry is made up of various standard industrial electrical and electronic components mounted directly on the circuit board 216. As one of the objectives of this system is to be universally mounted, either a twelve volt or a twenty four volt trailer operating voltage can be received by the control circuitry. The control circuitry will typically accept a voltage input range from 10 volts to 30 volts DC which is electronically converted to the necessary battery charging voltage to ensure the battery 136 is maintained at its peak operating condition. This is achieved through the inclusion of an industry standard isolated flyback power converter which acts as a trickle charging circuit allowing the battery to be charged. Charging is achieved at the operator's discretion by providing the trailer's reticulated voltage to the input dual conductor 178. Standard industrial relays which are mounted on the circuit board 216 are included to allow for the high current forward and reverse switching of the electric motor 201. The electric motor 201 current is monitored via the amplified voltage across a circuit board 216 mounted resistor and feed to the microprocessor. Circuitry is included to prevent failure of any of the electronic components should the battery 136 or supply voltage (not illustrated) be inadvertently connected in the reverse polarity. The microprocessor which is mounted on the circuit board 216 is programmable and includes the logic to control the system 200. All the devices electrically connected to the circuit board 216 as described in this art provides either input to or is operated via outputs from the circuit board 216 and its microprocessor. The logic includes failure algorithms which are indicated by a light emitting diode 195. Light emitting diode 194 is used to indicate the auto/manual status of the system.

[00106] The circuit board 216 and its microprocessor receives signals from the main operator panel 217 or the alternate operating panel 169 indicating the desired operation. Each panel allows for the automatic raise or lower cycle to be initiated by activating the raise or lower buttons respectively. A stop button is also included on

each operator panel 217 and 169 to allow for the immediate stopping of either automatic cycle. The control circuitry uses the indication as above-mentioned from the main operator panel 217 and the alternate operating panel 169 to undertake the necessary high current voltage switching to operate the system from the off to either the raise or lower modes. In effect the voltage as fed through the dual conductor 172 to the electric motor 201 is the battery voltage for the raise mode with the polarity being reversed across the dual conductor 172 and the electric motor 201 for the lower mode.

[00107] In this embodiment the control circuitry ensures the electric motor 23 current is limited to a set value. If the load is such that the electric motor 201 attempts to use excessive current the logic of the microprocessor will de-energize the voltage being feed to dual conductor 172. The supply will not be re-energized until both a short time delay has passed and the stop button of the main or alternate operator panel 217 and 169 has been operated. Such over current conditions will arise where the end of the stroke of the landing gear legs 4 and 5 has been reached and the electric motor 217 is left operating. Preferably when the landing gear legs are being lowered in high speed the system allows the operator to undertake other routine duties as the overload protection component of the system will stop the motor once the telescoping legs 4 and 5 have engaged the ground. In this embodiment the control circuitry is configured so that the change from high speed to low speed can take place automatically as described elsewhere in these teachings.

[00108] From Figure 15 of this embodiment it can be seen that the control circuitry includes a trailer brake air pressure interlock switch 164. This switch is closed when the brake air pressure drops to a point where the trailer brakes (not illustrated) are positively engaged. The inclusion of this element of the circuit design is optional and at the discretion of the operator as some applications would be hindered by the inclusion of such an interlock.

[00109] In an alternative embodiment not illustrated the dual conductor 179 is connected together, that is, electrically bridged out. This allows for the brake air pressure interlock switch 164 to be eliminated from the system.

[00110] In this embodiment sensors and actuators are included along with the

control circuitry to allow the gear change in the trailer landing gear to be undertaken automatically. The turntable clear interlock switch 165 and the legs up interlock switch 166 are used to sense the completed lower and raise automatic cycles respectively. The solenoids 154 and 155 are used to activate the change in gears within the trailer landing gear gear head 103. This is undertaken when the solenoids 154 and 155 act on the pneumatic valves 240 and 241 respectively. In this embodiment two miniature limit switches 167 and 168 are included which are mounted directly to the circuit board 216. These miniature limit switches 167 and 168 are activated by a gear position activating arm 250. When the miniature limit switches 167 and 168 are not operated then the microprocessor logic understands that the landing gear gear head 103 is in the low speed position. When the miniature limit switches 167 and 168 are both operated then the microprocessor logic understands that the landing gear gear head 103 is in the high speed position. When the miniature limit switch 168 only is operated then the microprocessor logic understands that the landing gear gear head 103 is not in either of the low or high speed positions and if a gear change is not in process then manual intervention may need to be undertaken. This embodiment also sees the main and location operator panels 217 and 169 being of a pressure return membrane button type.

[00111] In the embodiment as illustrated in Figures 8 to 15 a typical scenario for an automatic legs down cycle is initiated, when the system is not already operating, by the operator momentarily pressing the lower button on either the main operating panel 217 or the alternate operating panel 169 for less than three seconds. This signal is received by the microprocessor which after ensuring the gear head 103 is in the high speed mode via miniature limit switches 167 and 168 then starts the electric motor. The lower legs 4 and 5 are then lowered by the electric motor 201 as elsewhere described. When the landing gear lower legs 4 and 5 become engaged with the ground the electric motor 201 electrical current eventually reaches its preset upper current limit and the electric motor 201 is stopped. It should be noted at this point that in some circumstances the trailer and load may be so insignificant that the electric motor 201 electrical current preset upper limit is not reached and the landing gear lower legs 4 and 5 can continue to be lowered in the high speed mode. The

electric solenoid 154 is energized to activate the pneumatic valve 240. This valve passes pressurized air to the sub-chamber 235 to effect a gear change from high speed to low speed. The electric motor is pulsed in the raise direction to ensure meshing of the non synchronous gears in the gear head 103. When the low speed gears are engaged which is acknowledged via the miniature limit switches 167 and 168 the electric motor 201 is again energized to continue the lower legs 4 and 5 on their downward path thus raising the trailer. The automatic lower cycle is concluded on reaching one of three conditions:

[00112] The first condition being the electric motor 201 current has again reached the preset upper limit.

[00113] The second condition being that the turntable clear interlock switch 165 has been activated.

[00114] The third condition is that stop or raise buttons on either the main operating panel 217 or the alternate operating panel 169 has been operated.

[00115] The automatic raise cycle is activated, when the system is not already operating, and the raise button of either the main operating panel 217 or the alternate operating panel 169 is momentarily activated for less than three seconds. This signal is received by the microprocessor which after ensuring the gear head 103 is in the low speed mode via miniature limit switches 167 and 168 then starts the electric motor. The lower legs 4 and 5 are then raised by the electric motor 201 as elsewhere described. When and the turntable clear interlock switch 165 is deactivated and the landing gear lower legs 4 and 5 become clear of the ground the electric motor 201 electrical current eventually drops to its preset lower current limit then the electric motor 201 is stopped. The electric solenoid 55 is energized to activate the pneumatic valve 241. This valve passes pressurized air to the sub-chamber 236 to effect a gear change from low speed to high speed. The electric motor is pulsed in the raise direction to ensure meshing of the non synchronous gears in the gear head 103. When the high speed gears are engaged which is acknowledged via the miniature limit switches 167 and 168 the electric motor 201 is again energized to continue the lower legs 4 and 5 on their upward path thus lowering the trailer. The automatic raise cycle is concluded on reaching one of three

conditions:

[00116] The first condition being the electric motor 201 current has reached the preset upper limit.

[00117] The second condition being that the legs up interlock switch 166 has been activated.

[00118] The third condition is that stop or lower buttons on either the main operating panel 217 or the alternate operating panel 169 has been operated.

[00119] In this second embodiment there will be times when the landing gear lower leg 4 and 5 extension needs to be adjusted. This is achieved by holding the raise or lower buttons of either the main operator panel 217 or the alternate operator panel 169 for a period greater than three seconds. The logic of the microprocessor will recognize this holding of the raise or lower buttons and not continue in an automatic mode but only raise or lower the legs respectively for the period that the raise or lower buttons are activated. Gear change can still be undertaken manually and is effected by the operator manually acting on the system 200 to effect the axially displacement about the drive shaft 13 of the system 200 relative to the trailer landing gear.

[00120] In a third embodiment illustrated in Figures 16 and 17 a simplified mountable drive mechanism is illustrated. Whilst manually operated gear changes were contemplated earlier in this document, the third embodiment provides a simplified arrangement of this concept where the automated means for changing the gear ratios of the landing gear is removed. In this embodiment the speed change of a landing gear is effected manually by pushing or pulling the assembly on the drive shaft 13 to effect the speed change through the gear illustrated in Figure 3C. As shown in Figure 16, the output shaft 13 of the landing gear is concentrically located in a sleeve 260 which is in turn held to the shaft 13 by a locking pin 261. Thus the output of the gear box 203 directly drives the shaft 13 of the landing gear. The pinned arrangement means that a lateral push on the whole assembly displaces the shaft 13 inwards or outwards to change the gear ratio through the gearing shown in Figure 3C. As in the embodiment shown in Figure 8, the lower face of the housing 202 has a projecting spigot that is a sliding fit within the steel rod 209 that constitutes

the torque arm. The pinned interconnection between the output 260 of the gear box 203 of the drive mechanism and the shaft 13 of the landing gear allows the unit to be readily demountable. This feature also allows the conventional crank handle to be readily reinstated in the event of a breakdown or loss of power.

[00121] A further feature of the embodiment of Figures 16 and 17 is the use of a two speed electric motor. By use of eccentric brushes a high speed but lower torque output can be produced from the motor. The motor switches to a lower speed and higher torque on demand so that when there is no load on the landing gear the electric motor automatically selects the higher speed. As the load on the landing gear increases the motor switches to the higher torque and lower speed mode.

[00122] The assembly illustrated in Figures 16 and 17 includes the motor 201, a gearbox 203, and an electronic controller. The gearbox 203 has an output shaft 240 and a control panel 217 on the front of the housing 202 of the assembly. A torque arm 209 projects from the rear of the assembly to be connected to the landing gear.

[00123] To support the diverse functionality of the powered trailer jacking system an electronic microprocessor is incorporated as part of the control electronic circuitry. The microprocessor and the control circuitry are mounted within the drive assembly housing on a purpose designed printed circuit board.

[00124] The supply from and to the battery and to the electric motor is via short but large diameter electrical conductors. This minimizes the voltage drop between the battery and the electrical motor. These conductors enter the housing through seals and are soldered to the printed circuit board. A thermally acting fuse is located inline with this heavy duty conductor as it connects to the battery to avoid excessive currents in the event of misuse or failure of any one of the components of the system.

[00125] Electrical relays are used to switch the large currents from the battery to the electric drive motor. The relays are controlled by the microprocessor and are mounted on the printed circuit board.

[00126] The battery voltage is maintained with the incorporation of a purposed designed trickle charge circuit fed from the existing trailer electrical wiring system. The input voltage can vary from 10 to 30 volts. Current is limited to a few amps to minimize any effects on the trailer wiring system. Two small diameter conductors are

utilized to carry this charging current from the trailer wiring system to the printed circuit board. These conductors are soldered to the printed circuit board.

[00127] The electric motor is protected from excessive current and temperature conditions. The circuit includes a printed circuit board mounted resistor coupled to an analogue to digital converter to measure the current flow to the motor. In some instances this current related signal is used to control an element of an automatic cycle. In other circumstances it prevents excessive and damaging currents passing to the motor and its associated control circuit elements. A thermal resistor is used to sense the temperature of the motor with its resistance monitored to assess when the motor temperature has reached an unacceptable level. At preset current and temperature limits the motor is de-energized. The electronic circuit also protects against the inadvertent reverse polarity connection of either the battery or the charging supply voltages.

[00128] The circuit is so configured to minimize the quiescent current drain when the product is idle to ensure that the battery is not discharged in the event the system is idle for extended periods and no charging supply voltage is connected.

[00129] Input to the microprocessor is via membrane electrical switch panels. The main panel is located on the face of the device and an alternate panel is mounted on the opposite side of the trailer. The panels are identical in function. The main panel additionally include LEDs (light emitting diodes) to signal a fault condition and to indicate the battery charging system is functional. The panels have switches that enable auto functions that allow the legs to be lowered to the ground, raised to the travelling position and "inched" without the operator required to be in attendance. There is a stop button on each panel in the event of a safety issue where the legs may need to be stopped in an emergency or any of the auto functions needs to be halted.

[00130] The stop button deactivates any auto operation. The auto lower switch activates an auto lowering of the legs which only stops when the motor current increases to a preset level. This will normally happen when the leg comes in contact with the ground. The auto raise switch activates an auto raising of the legs which only stops when the motor current increases to a preset level. This will normally

happen when the leg is fully raised and hits the upper limit of travel. The inching switch will lower the legs for a preset time. Multiple sequential activation of the inching switch results in corresponding multiple time continuous operation. In each auto mode the default operation is to run the motor in high speed (lower torque). The controller continually senses the current and at preset upper current limit the controller will change to the low speed function of the electric motor to provide the additional torque that may be required. In the event that the unit is operating in the low motor speed and the current drops to a preset lower level than the controller will undertake to switch the electric motor to the high speed mode. Time delays are utilized in the above-mentioned switching to ensure the motor is not continually being switched between the two different motor speeds.

[00131] For safety reasons an air pressure switch is used to sense the positive operation of the trailer air brakes. The unit is interlocked to ensure that the powered trailer jacking system cannot lower whilst the brakes are off.

[00132] In addition to its use in raising and lowering a landing gear as describe above, the drive mechanism can be used to provide the motive power for turning the drive shafts 401 of various other devices, replacing power from a human source or another powered source. In the following arrangements described and shown in Figures 18 through to 20, the devices are known devices configured to be powered by a human operator. The rotary motion (winding) of the crank handle 10 is imparted to the drive shaft 401 through the adapter 402 on the end of the shaft 401 which can fall under any generic designs common to this concept.

[00133] Figure 18 shows a conventional hopper trailer 400 equipped with a hopper door 408 that is operated by manual activation of a crank handle 10. The hopper door 408 slides in fabricated slots which form part of the base of the hopper. The hopper door 408 has two gear racks 404 solidly connected to it on either side to ensure smooth operation. Gears 403 engage the racks 404. The gears 403 are mounted on a gear shaft 405 which in turn is solidly mounted to the trailer via bearing supports 407. The gear shaft 405 is driven through a universal joint 406 which is attached to the drive shaft 401. The outboard end of the drive shaft 401 is supported by a bearing and bracket 409 connected to the trailer 400. The exposed end of the

drive shaft 401 is fitted with a spigot 402, typically hexagonal in shape.

[00134] When the hopper door 408 is required to be operated the handle 10 is taken from a storage location and fitted to the drive shaft spigot 402. The operator can then manually provide a rotary force using the handle which through the device as described above will result in the linear motion of the hopper door 408. This will open and close the door 408 dependant on the direction of rotation of the handle 10.

[00135] Figure 19 illustrates a typical extendable trailer 500 where the side 508 is extendable by operation of manual crank handle 10. The extendable side 508 has four gear racks 404 solidly attached to it, one located at each lower corner and one at each upper corner of the extendable side 508. The extendable side 508 is mounted on tracks (not shown) located in the trailer 500 that afford a smooth operation of the extendable side 508. The extendable side 508 is in the closed position while travelling and in the fully extended position while in use while the trailer 500 is parked.

[00136] As illustrated by the enlarged, cut-away portions in Figure 19, the gear racks are acted on by mating gears 403 which in turn are fixed to gear shafts 405 one located at the rear of the extendable side and the other located at the front of the extendable side. These shafts 405 are solidly mounted to the trailer 500 structure via bearing blocks 407. The lower end of the gear shafts 405 are coupled to a miter (right angle) gear box 506 mounted solidly to the trailer chassis and below each corner of the extendable side 508. These gear boxes 506 are in turn connected to a drive shaft 401 that extends from the rear of the trailer 500 to the front gear box (not shown). The rear of the shaft is supported by a bearing and bracket 509 connected to the trailer 500. The exposed end of the drive shaft 401 is fitted with a, typically hexagonal, spigot 402.

[00137] When the extendable side 508 is required to be operated the handle 10 is taken from a storage location and fitted to the drive shaft spigot 402. The operator can then manually provide a rotary force using the handle which through the device as described above will result in the linear motion of the extendable side 508. This will open and close the side 508 dependant on the direction of rotation of the handle 10.

[00138] In another arrangement as shown in Figure 20 the trailer 600 is fitted with a rollover tarping system 608 operated by a manual crank handle at the rear of the trailer 600. On one side of the trailer 600 the covering tarp 608 is attached to the upper edge 610 of the trailer 600. This edge also has several simple stops 607 to prevent the tarp 608 rolling over that edge of the trailer. The tarp 608 wraps around a longitudinal tarp shaft 605 and is attached down the length of the shaft. A drive shaft 401 is connected to the rear end of the tarp shaft 605 through a universal joint 406 and rolls from one side of the trailer 600 to the other. It is restricted once the tarp 608 is fully unwound and the drive shaft has dropped over the retaining lip 612 of the trailer 600. The tarp shaft 605 has flexible spring 611 attached to the forward end of the shaft 605 with the other end attached to the top forward corner of the trailer 600 adjacent the retaining lip 612. The flexible spring 611 provides a pulling force to the tarp shaft 605 in the unrolling direction. The flexible spring 611 may be a material coated rubber cord or similar typical to the application.

[00139] A crank handle 10 is mounted at the free end of the drive shaft 401. Alternatively, the crank handle may be attached to the drive shaft 401 in such a manner, for example telescopically, to allow longitudinal movement or extension of the crank handle 10/drive shaft 401 combination. The combination may be demountable such that while travelling the crank handle 10/drive shaft 401 combination is stowed in a retainer 613. When the tarp 608 is required to be operated the handle 10 is released from its stowed location and the operator may extend the crank handle 10/drive shaft 401 combination to afford a better posture to operate the crank handle 10.

[00140] The operator can then manually provide a rotary force using the handle 10 which through the device as described above will result in the linear motion of the tarp 608 across the top of the trailer 600. This will open and close the tarp 608 dependant on the direction of rotation of the handle 10. Once the tarp drops over the retaining edge 612 the operator will continue to rotate the handle 10 in the same direction which will cause the tarp 608 to "lock" up under the retaining edge 612. This is then maintained by stowing the handle 10 in its retainer 613. When the tarp 608 is being opened it is rolled up on the tarp shaft 605 and the tarp itself will provide the

resistive force to track it to the trailer edge 610 against the stops 607. This is not the case when the tarp 608 is being closed. In closing, the force of the flexible spring 611 together with a force that the operator exerts via rotating the crank handle 10/drive shaft 401 combination provides the necessary side force to see the tarp unroll across the trailer.

[00141] The inventive demountable drive mechanism is applied to replace the manual crank handle of the operating devices described above. The drive mechanism includes a reversible geared electric motor and associated control mechanism to provide the drive to the drive shaft 401 for the various apparatus described above. However it is not intended to limit use of the drive mechanism to the devices described but use these as exemplary devices of the typical manual crank applications to which the drive mechanism can be applied.

[00142] Figures 21, 22 and 23 illustrate several preferred embodiments of the drive mechanism applied to the operating devices of Figures 18, 19 and 20 respectively. For the purpose of avoiding repetition, features of the drive mechanism hereinbefore described are also applicable to the following examples as is suitable.

[00143] In the following configurations the manual crank handle 10 is not used but motive power is provided by an electronically controlled geared reversible electric motor 200 of the demountable drive mechanism.

[00144] Figure 21 illustrates one embodiment of the present invention as used to operate the hopper gate of Figure 18. The drive shaft 401 has a round diametral hole 420 close to its end. The geared motor 200 of the drive mechanism is mounted on the drive shaft 401 with a pin 421 which passes through the hole in the drive shaft of the geared motor 200 and the hole 420. This pin 421 is a press fit within the hole 420. A torque arm 430 is used to resist the torque that is to be imparted to the drive shaft 401. The torque arm 430 is solidly mounted to a purpose designed bracket 422. The bracket 422 is solidly mounted to the trailer 400. The torque arm 430 is mounted in a socket adjacent to and parallel with the drive shaft 401. With the geared motor 200 mounted the operation of the motor will impart a turning motion on the drive shaft and through the mechanical arrangement previously described and will cause the hopper door 408 to open or close as the case may be depending on the direction of

rotation of the geared motor. Described further below is the electrical and associated equipment necessary to allow the geared motor 200 to operate effectively.

[00145] Figure 22 illustrates another embodiment of the present invention as used to operate the expandable side of the trailer of Figure 19. The drive shaft 401 has a round diametral hole 420 close to its end. The geared motor 200 is mounted on the drive shaft 401 with a pin 421 which passes through the hole in the drive shaft of the geared motor 200 and the hole 420. This pin 421 is a press fit within the hole 420. A torque arm 530 is used to resist the torque that is to be imparted to the drive shaft 401. The torque arm 530 is solidly mounted to a purpose designed bracket 522. The bracket 522 is solidly mounted to the trailer 400. The torque arm 530 is mounted adjacent to and parallel with the drive shaft 401. With the geared motor 200 mounted the operation of the motor will impart a turning motion on the drive shaft and through the mechanical arrangement previously discussed will cause the extendable side 508 to extend or retract as the case may be depending on the direction of rotation of the geared motor. Described further below is the electrical and associated equipment necessary to allow the geared motor 200 to operate effectively.

[00146] Figure 23 illustrates another embodiment of the present invention as used to operate the rollover tarping system of the trailer of Figure 20. The drive shaft arrangement is modified so that the drive shaft 401 is connected to the tarp shaft 605 through standard miter gearbox 606. Additionally, the gearbox is solidly mounted to a tarp arm 625. The tarp arm 625 is slidably mounted by a pivot box 626 that is mounted on the front bulkhead of the trailer 600. The pivot box 626 uses standard clock springs (not shown) to provide force via the tarp arm 625 onto the tarp 608 to assist it to unroll or open. The lower end of the drive shaft is supported by standard bearing arrangement (not shown) within the tarp arm 625. The drive shaft 401 has a round diametral hole 620 close to its end. The geared motor 200 is mounted on the drive shaft 401 with a pin 421 which passes through the hole 620 and a corresponding hole 621 in the drive shaft of the geared motor 200. This pin 421 is a press fit within the hole 620. A torque arm 630 is used to resist the torque that is to be imparted to the drive shaft 401. The torque arm 630 is solidly mounted via a purpose designed bracket 632 to the tarp arm 625. The torque arm 630 is mounted

adjacent to and parallel with the drive shaft 401. With the geared motor 200 mounted the operation of the motor will impart a turning motion on the drive shaft and through the mechanical arrangement previously described will cause the tarp 608 to open or close as the case may be depending on the direction of rotation of the geared motor. Described further below is the electrical and associated equipment necessary to allow the geared motor 200 to operate effectively.

[00147] A typical scenario of the operation of the present drive mechanism for all of the above embodiments is described as follows. The operator having brought the trailer to a stop and applied the vehicle brakes will disembark from the truck and approach the geared motor 200 mounted on the trailer. The operator will set the drive mechanism to rotate in the direction required by activating the desired button on the keypad 217 (see Figures 8 and 9) that forms part of the geared drive 200. The operator can then go about other duties as may be required to undertake from time to time. The geared motor will stop automatically when it has achieved the full travel of the devices described above. When it is required to activate it in the reverse direction the operator will approach the geared motor 200 again. The operator need only press the appropriate button on the keypad 217 and walk away. In a different embodiment the operator may elect to use the duplicate remotely mounted keypad 169 in lieu of the keypad 217.

[00148] In yet a further embodiment of the drive mechanism a remote keypad may be installed in the truck (not show). In this embodiment an operator has the ability to operate the unit from within the cabin of the truck.

[00149] In another embodiment a manual override function of the drive mechanism could be used where the geared motor 200 may have malfunctioned or if there is a complete failure or breakdown in the power supply but it is desirous to still operate the drive shaft 401. A manual override adapter 701 can be used to operate the device while still leaving the geared motor 200 mounted to the drive shaft 401. The geared motor output shaft 205 includes a direct drive socket in the form of a square hole 702 on the front cover 211 of the geared drive 200. The geared drive front cover 211 has an aperture 703 aligned with the square hole 702. Typically a grommet or plug 704 is fitted to the aperture 703 to avoid the ingress of dust and

moisture. Removing the grommet 704 and inserting the adapter 701 into the square drive hole 702 allows the operator to manually override the drive mechanism. Force is exerted on the adapter 701 via a standard tool typically used in the industry or by attaching the crank handle 10 the adapter 701.

[00150] The drive mechanism has been designed to be readily demounted as elsewhere described. However, in some scenarios it may be difficult to repeatedly mount and demount the drive mechanism due to lack of tools, skills or poor accessibility. In this case, the mechanism may remain mounted. The manual override function ensures that the drive mechanism can remain where it is and allow the operator to use the operating device manually or electrically.

[00151] In a further embodiment of the invention as illustrated in Figure 25 a wireless remote control unit 741 is installed to operate the drive mechanism via wireless remote switching. The wireless remote receiver and controller 741 is typically mounted adjacent the geared motor 200 and the battery 136 on the truck or trailer chassis. The wireless controller is provided with 12 volt power from the battery 136 of the drive mechanism. The harness connectors 742 and 743 connecting the remote keypad 169 to the geared motor 200 is routed via the wireless controller 741. A small wireless transmitter 744 is used in conjunction with the wireless remote receiver and controller 741. Typically the transmitter 744 may be stored on an operator's key ring or the like.

[00152] The operation of the wireless remote embodiment is achieved by depressing the buttons on the transmitter 744. The wireless controller 741 receives the signal. The controller 741 incorporates electronic circuitry, which is of standard technology known in the industry. It activates the invention by mimicking the remote keypad 169 functionally.

[00153] In an another embodiment of the invention as illustrated in Figure 26 a master control unit 760 is used to receive external inputs 761 & 762 and control the operation of one or more embodiments of the invention. The master control unit is typically mounted adjacent the geared motor 200 and the battery 136 on the trailer chassis. The master control unit 760 is provided with 12 volt power from the battery 136. The harness connector 742 is connected to the master control unit 760 via a

harness and connector 763. Input to the master control unit 760 may come from remotely mounted operator switches 761 or field switches 762. Typically the field switches 762 may be limit switches, proximity sensors, inclinometers and other similar devices common and known to the industry.

[00154] A typical use for the operation of the master control unit 760 is in the self leveling of a trailer where a landing leg is attached to each corner of a trailer. Each leg has a drive mechanism mounted such that each leg can be powered. The master control unit 760 is linked to: the drive mechanism mounted on each leg; an operator panel with switches 761; and several field inclinometers 762 mounted to the trailer chassis. A push button 761 is activated on the operator panel. The master control unit will then send signals to each leg mounted invention to operate. The master control unit 760 will take input from the inclinometers 762 to allow the trailer to be brought to a level position using the drive mechanisms to provide the motive force.

[00155] In all embodiments of the demountable drive mechanism, the electric motor current is measured using a standard shunt circuit. In this circuit the motor current passes through an electrical resistor and the voltage is measured across the known resistor and the voltage drop is proportional to current flow. This voltage drop can be converted into a signal that can be recognized by a microprocessor. The microprocessor can be programmed with an algorithm that compares product life with usage. The motor current is measured over small time intervals and accumulated as a current/time measurement. This information is stored in an electronic memory device within the control circuitry. The accumulation of the motor current/time data is then compared to a known wear rate of the electric motor brushes for varying operating currents. The usable duty or duty of the product is a function of the physical brush size and material. For a given brush size there is a relationship between current time and wear rate. This relationship is illustrated in the graph of Figure 27 which is a plot of brush wear against motor current.

[00156] The wear of the electric motor is estimated from the current/time usage and when this value approaches the consumable wear available then the product provides an indication via a light emitting diode LED on the fascia of the product that it is nearing the end of its available life. The state at which the LED illuminates can be

adjusted but in one embodiment it is considered that the light would come on when the product is in its last 10% or preset portion of usable life.

[00157] In a further embodiment, the control circuit can provide an indication via an LED of the percentage of life used when a present sequence is entered by the fascia switches. The LED can flash once for every estimated 10% of product usable life still available. In this way, the user of the device has a ready visual indication of usable life still available. The 10% increment is merely one option.

[00158] In another option, a computer can be interfaced with the drive mechanism via a purpose designed interface cable and can be used to interrogate the data stored in the memory of the microprocessor and provide visual or printed reports.

[00159] In the embodiment shown in Figure 28, the electronic controller monitors the current passing through the brushes and when the motor becomes open circuit then the logic assumes that a brush has been fully consumed and worn away. In this embodiment the control logic swaps to the alternative brush normally used for the alternative speed in a two speed electric motor. Figure 28 is a schematic illustration of a brush configuration and shows a common brush, the high speed brush and a low speed brush. In this embodiment an LED is mounted on the fascia of the product to provide a ready indication of failure of a brush and transfer to the alternative brush. This facility ensures that the drive still operates but provides the operator with a warning of the need for brush replacement.

[00160] In a third embodiment, the motor operating current is monitored in small time increments and a maximum allowable current is set as a percentage above the immediate current. In this manner, a significant and rapid increase in the electric motor current will result in shut down of the motor. This feature prolongs motor life and reduces the likelihood of brush burnout.

[00161] In this embodiment shown in Figure 29, the electric motor is activated by use of electronic relays, usually solid state relays, and known typically as field effect transistors (FET). To avoid a massive rush in current when the motor is turned on, the electric motor voltage is pulsed to effectively cap the current peak. The capping of this peak is illustrated graphically with reference to Figure 29 which is a

plotted motor current against time.

[00162] It will be understood to persons skilled in the art of the invention that many modifications may be made without departing from the spirit and scope of the invention.